MECH

SE/Sem-III/MECH/Thermodynamics/May 14

QP Code : **NP-18643**

(3 Hours) [Total Marks : 80

N. B. : (1) Question No. **1** is **compulsory**.
(2) Solve any **three** questions from remaining **five** questions.
(3) Assume suitable data if required.
(4) Use of Mollier Chart, Steam table is permitted.

1. (a) What is cut-off ratio? How does it affect the thermal efficiency of Diesel cycle? 4
(b) State the Clausius-Clapeyron equation. 4
(c) I kg of steam at a pressure of 17 bar and dryness 0. 95 is heated at a constant pressure until it is completely dry. Determine: (i) Increase in volume (ii) Quantity of heat added. 4
(d) Differentiate between non-flow and flow process. What is steady flow process? 4
(e) Define adiabatic flame temperature and explain its practical significance. 4

2. (a) Derive Maxwell's equations. 4
(b) Show that the efficiency of all reversible heat engines operating between the same temperature limits is same. 8
(c) 0.06 m^3 air at 5 bar and 200°C expands isentropically until the pressure becomes 2 bar. It is then heated at constant pressure until the enthalpy increase during this process is 80 KJ. Calculate work done in each process and total work done. 8

3. (a) What are the four processes which constitute the Stirling cycle? Show that the regenerative Stirling cycle has same efficiency as the Carnot cycle. 6
(b) An engine with 30% efficiency drives a refrigerator having COP of 5. What is the heat input into the engine if 10 MJ of heat is removed from the cold body by the refrigerator? Find total quantity of heat rejected to the surrounding. 6
(c) The products of combustion of an unknown hydrocarbon C_xH_y have the following composition as measured by an Orsat apparatus: 8
CO_2 = 8.0%, CO = 0.9% O_2 = 8.8% and N_2 = 82.3%
Determine : (i) The composition ofthe fuel.
(ii) The air-fuel ratio.
(iii) The percentage excess air used.

4. (a) Define . (i) Dryness fraction 4
(ii) Critical point
(iii) Triple point
(iv) Degree of superheat
(b) 0.6 m^3 of air at 37°C and I bar is heated at constant volume until the pressure becomes 2 bar. It is then cooled at constant pressure to its original temperature. Calculate the change of entropy in each process. 6

[TURN OVER

Con. 12420-14.

(c) In an air standard cycle pressure at the beginning of compression is I bar, while temperature is 310 K. Compression ratio is 10:1, Heat added is 2800 KJ/Kg of charge. The maximum pressure limit is 70 bar. If heat is added partially at constant volume and partially at constant pressure, find: 10

(i) Air standard efficiency (ii) Mean effective pressure.

5. (a) Explain: (i) Enthalpy of reaction (ii) Enthalpy of formation (iii) Heating value. 6

(b) How much of the 1200 KJ of thermal energy at 700 K can be converted to useful work if the environment is at 25°C 4

(c) A turbocompressor delivers 2.33 m^3/s of air at 0.276 MPa, 43°C which is heated at this pressure to 430°C and finally expanded in a turbine which delivers 860 kW. During expansion there is a heat transfer of 0.09 MJ/s to the surroundings. Calculate the turbine exhaust temperture if changes in kinetic and potential energy are negligible. 10

6. (a) Derive an expression for availability of a non flow process. 8

(b) In a reheat cycle steam at 500°C expands in H.P. turbine till it is saturated vapour. It is reheated at constant pressure to 400°C and then expands in L. P. turbine to 40°C.If the maximum moisture content is limited to 15% at the turbine exhaust, find 12

(i) Reheat pressure.
(ii) The pressure of steam at inlet to H.P. turbine.
(iii) Net specific work output.
(iv) Cycle efficiency.
(v) Steam rate.
